From: Como, Joe

To: Peevey, Michael R.; Florio, Michel Peter; Peterman, Carla J.; Ferron, Mark J.; Sandoval, Catherine J.K.

cc: Fitch, Julie A.; Charles, Melicia; Colvin, Michael; Kamins, Sara M.; Khosrowjah, Sepideh; Baker, Amy C.; Brown, Carol A.; Stevens, Brian

Subject: Analysis prepared by ORA for Track 2 of the LTPP proceeding (R.12-03-014)

Dear President Peevey and Commissioners:

Attached for your information is testimony prepared by ORA for Track 2 of the 2012 Long-Term Procurement Planning (LTPP) proceeding. At least one advisor indicated an interest in seeing this analysis even though this testimony is not part of the record.

Track 2 focused on determining whether California's system resources in 2022 are sufficient to support the State's goal of meeting 33% of demand with renewable portfolio standard (RPS) resources.

Shortly before the due date for service of the testimony, an Assigned Commissioner and Administrative Law Judge Ruling cancelled Track 2, indicating "[t]here has been some indication that system flexibility needs may be low or non-existent depending on the level of local capacity procurement authorized in Track 4."

The modeling ORA had already completed estimated whether additional resources will be needed in 2022 to balance supply and demand. The results are presented in the attached testimony. ORA similarly concluded that there is no immediate need to authorize procurement to meet system flexibility needs.

We would be happy to discuss this further with you or your advisors.

Thank you.

Joe Como
Office of Ratepayer Advocates

ORA's testimony in the 2012 Long Term Procurement Proceeding, Track 2:
Executive summary

(January 2014)

The California Public Utilities Commission (CPUC) oversees biennial Long-Term Procurement Plan (LTPP) proceedings to "ensure that California's major investor-owned utilities (IOUs) can maintain electric supply procurement responsibilities on behalf of their customers."[1] In these LTPP proceedings, resource needs are evaluated ten years into the future for the entire electric system in California and also for transmission-constrained local areas.

Parties to the LTPP proceeding opened in 2012, Rulemaking (R.)12-03-014, considered issues related to "system variability" in Track 2 of that proceeding. A series of workshops explored the methodologies associated with understanding and quantifying system variability. "System variability" is the interaction of changes in supply and demand, while "operational flexibility" refers to the resources needed to respond in real time to changes in supply and demand. California faces increased system variability because of its increasing reliance on intermittent renewable resources including wind and solar and it is therefore important to plan for adequate operational flexibility to meet system variability.

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[1] Scoping Memo and Ruling of Assigned Commissioner and Administrative Law Judge, issued May 17, 2012, in Rulemaking (R.) 12-03-014, p. 2. Available at http://docs.cpuc.ca.gov/SearchRes.aspx?DocFormat=ALL&DocID=60474

Parties were on the verge of filing testimony when a ruling was issued September 16, 2013, cancelling Track 2 of the proceeding. The following summary contains highlights of testimony prepared in late 2013 for the Office of Ratepayer Advocates (ORA)[2] by Robert M. Fagan and Patrick Luckow of Synapse Energy Economics. The complete testimony is attached.

Track 2 of the 2012 LTPP focused on determining whether California's electric system resources[3] in 2022 are sufficient to support the State's goal of obtaining 33% Renewable Portfolio Standard (RPS) resources to meet demand. Track 2 modeling estimated whether or not such additional resources will be needed in 2022 to balance supply and demand, taking into account the many system operational details projected for that year, including load growth, the ability of the transmission system to import resources from outside the system, the outage and response rates of generating units, and whether intermittent renewable resources provide more than 33% of California's energy in 2022.

ORA's Track 2 testimony reported the results of ten alternative Track 2 modeling scenarios ("ORA Scenarios") that Synapse executed on behalf of the ORA. Synapse used the Plexos modeling tool[4] to run the ORA Scenarios, starting with benchmark input files that the CAISO used for its Track 2 modeling.

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[2] The Division of Ratepayer Advocates was renamed the Office of Ratepayer Advocates effective September 26, 2013, pursuant to Senate Bill No. 96 (Budget Act of 2013: public resources), which was approved by the Governor of California on September 26, 2013.

[3] The system resources at issue are under the control of the California Independent System Operator Corporation (CAISO), which manages the flow of electricity for about 80 percent of California and a small part of Nevada, which encompasses all of the investor-owned utility territories and some municipal utility service areas. http://www.caiso.com/about/Pages/OurBusiness/UnderstandingtheISO/default.aspx

[4] The Plexos modeling tool is an hourly production cost simulation model used for resource planning.

Synapse's results show the projected patterns of electric power resource availability in 2022 during either i) all hours of the year, or ii) during just the hours in the projected peak summer month (July);[5] and how these patterns are affected by key scenario assumptions. The ORA Scenarios focus mainly on the impact of different levels of preferred resource (i.e., energy efficiency (EE), demand response (DR), solar photovoltaic (PV))[6] deployment by 2022. A few ORA Scenarios address import limitations and the potential addition of resources given the retirement of the San Onofre Nuclear Generating Station (SONGS) resource.[7]

Table 1 below shows a generally progressive reduction in identified "shortage" amounts from CAISO's base run shortage level of 2,621 MW (an amount that does not consider any effect of Track 1 authorizations not explicitly included in CAISO's base model[8]) in 2022. As incremental EE, DR, or PV is deployed (supplemental to the amount assumed in the CPUC scoping memo for the given scenario), or when demand response resources are assumed to be available for a different ("shifted") 6-hour window – namely, from 1 p.m. to 7 p.m. instead of from 11 a.m. to 5 p.m. – the modeled shortage level declines.

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[5] Some model runs were executed for all 12 months of 2022; and some ORA scenarios were executed just for July, the month in which demand is usually highest.

[6] Preferred resources also include combined heat and power (CHP) and storage. Primarily to minimize the permutations of modeling cases, in this examination we have not executed any modeling runs that varied the underlying case (base, Transmission Planning Process (TPP), high distributed generation (DG)/demand side management (DSM)) assumption for CHP deployment or storage (50 MW). To the extent that additional CHP or storage resources are deployed beyond that assumed for the case, our results will underestimate the system "headroom", or exaggerate any "shortage" finding.

[7] Authorization of resources to address the SONGS outage are part of Track 4 of the 2012 LTPP proceeding.

[8] CAISO has stated that the Moorpark sub-area of Big Creek Ventu fosail H resource, and preferred Track 1 procurements were excluded from its modeling.

In scenarios using the base load forecast and high levels of EE, DR, PV, and shifted DR availability, the "shortage" amount disappears (ORA Scenario 6), as it does in ORA Scenario 5 (high EE only). Excess available capacity during the tightest hour of the year is also observed in the model's results for CAISO's high DG/DSM scenario.

The analysis shows how different levels of resource deployment in 2022, across different net load forecasts, would lead to modeled surplus or shortage of resources at different points in time in that year. Generally, many modeled scenarios indicate shortages that occur for extremely brief intervals during one day of one summer month, with surplus capacity for the rest of the hours of the year. Modeled scenarios using more aggressive pursuit of preferred resources exhibit surplus capacity even during the tightest hour of the year.[9]

Modeling results that show occasional "shortages" do not imply that conventional gas-fired gas turbine or combined-cycle generation should be authorized for procurement at this time in an amount equal to the shortage capacity amount. The projected *patterns and duration* of modeled surplus or shortage should be evaluated when considering procurement decisions.

The modeling does not address the optimal timing for any resource procurement that is warranted or the best method of procurement. Based on current modeling results, ORA recommends limiting any procurement authorization to preferred resources.

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[9] It is notable that these scenarios, with higher levels of EE, DR and PV – and all other ORA Scenarios - contain no explicit assumptions for increased storage resources (e.g., up to 1,325 MW that may come to fruition by 2022 as authorized in the Decision 13-10-040) other than the 50 MW of storage authorized in Decision 13-02-015.

Table 1
Summary Results Plexos Hourly Modeling – July 2022 – ORA Scenarios

Scenario	Modeled Peak Shortage H H I MW	Duration of modeled shortage H hours H days I	Comments
CPUC Scenarios Executed by CAISO			
Base			
TPP HOct [10]	Revision I		
High D DSM			
ORA Scenarios Base Load			
Shift DR Available			DR p m instead p m
Shift DR Available and High DR			High DR separate from S Available
High PV			
High PV and Shift DR Available			
High EE			
High EE High PV High DR Shift DR			
Shift DR Available and Relax SCE Import			in area gen
Shift DR Available and Relax CA Import			Use High D DSM case in limit
MW Addition Shift DR Available High DR Relax CA Import			Add MW SCE Track
ORA Scenarios - TPP Load			
Mid EE DR and DR Available and Mid PV HSept TPP inputs posting I			

Notes

Track fCsrsiek rVesntumrae nHtt Bciogn sidered MWnI these ru it was used all shortages thdescnaemsent Hor surpluses in

CAISO scenarios exclude any preferred resource exceptions that the preferred resource assumptions from the Track sc

[End of Summary]

[10] Initial TPP results provided in the August 26th, 2013 LTPP workshop showed 5,359MW of shortage with a duration of 16 hours over 4 days. Afterwards, CAISO updated the model with new demand response assumptions and updated minimum and maximum capacities for some generating resources.

Docket:	:	R. 12-03-014
Exhibit Number	:	
Commissioner	:	
Admin. Law Judge	:	
ORA Witnesses	:	Robert M. Fagan Patrick Luckow

OFFICE OF RATEPAYER ADVOCATES
CALIFORNIA PUBLIC UTILITIES COMMISSION

TESTIMONY OF ROBERT M. FAGAN AND PATRICK LUCKOW, SYNAPSE ENERGY ECONOMICS, ON BEHALF OF THE OFFICE OF RATEPAYER ADVOCATES

Final - Post Track 2 Cancellation – October 23, 2013

Order Instituting Rulemaking to Integrate and Refine Procurement Policies and Consider Long-Term Procurement Plans
Track 2

(RM.12-03-014)

San Francisco, California
September, 2013

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INTRODUCTION AND SUMMARY OF TESTIMONY

Q What is the purpose and scope of this

A The primary purpose of ttshiosf tteesnt imony
alternative Track modelinygnaspcseenaerxiocsut eHd
behalf of the California OSfyinacpsoef uRatdepahyer
Plexos modeling tool to runntchmeaORAifspeutnafib
posted by the California IndmepeHCnAdIeSnOtSystem
completion of its modeling work

Synapse s results show the pespoujrecteadpaltlab
in during either iusstt atlhle hhouurrss oifnt the
projected peak s[1]ummaen dmohnowthHseky patterns ar
scenario assumptions The pORAt Sceendarifoesrfo
levels of preferred resouracned rHesponse HeDnRer
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phase of this proceeding thaeturowcell prooucnoswnecment
given the retirement of theoSanHSOONSGre Nucle
resource

We also discuss these resulatts afeexcatmintnhieng th
integration of renewable reslotusrcmeesanafnodre xpla
possible procurement actions We subsequen
recommendations informed by sthseteenst uwlitt shofthe
state s loading order policy

Q How does your analysis inform procurem

The driving factors affecting bortohs thhee cpprroojee
the procurement strategy to smteieenmton syuccho mteaeidn sa
new analyses uses informathieonCaflrioomri neixai stPun
Utilities Commission HCPUCl Ii fSocreniaEnoetrgy I
Commission HCEC I load forecceacsatsernsr ecoagmndize
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month with surplus capaceitay forMtohdeledst o

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[1] Some model runs were executed for all 12 months of 2022; and some ORA scenarios were executed just for the indicated "tight" month, July.

[2] Preferred resources also include combined heat and power (CHP) and storage. Primarily to minimize the permutations of modeling cases, in this examination we have not executed any modeling runs that varied the underlying case (base, Transmission Planning Process (TPP), High distributed generation (DG)/demand side management (DSM)) assumption for CHP deployment or storage (50 MW). To the extent that additional CHP or storage resources are deployed beyond that assumed for the case, our results will underestimate the system "headroom", or exaggerate any "shortage" finding.

scenarios using more aggressive pursuit of the p[...]
CPUC CEC high levels of EE, DR and PV [...]
tightest hour[3] of the year

In our opinion modeling results that show [...]
conventional gas fired gas generation [...]
equal to the shortage capacity procurement should [...]
time The *patterns and duration* of modeled surplus or sho[...]
taken into account when considering Track procurem[...]

The modeling itself says nothing about the o[...]
procurement that is warranted [...]
procurement California s [...]
based resource development I [...]
issue and explain our position that [...]
Honly I is the best course at this time

Q How does your analysis account for Track [...]
effects on any Track determination

A CAISO s analysis and the ORA Scenarios [...]
authorized during Track[4] include MW of CC a[...]
southern CA HSouthern California [...] MW [...]
Hlocated in the SCE[5] [...]
Creek Ventura HMoorpark sub [...]
and the preferred resources [...] ORA [...]
Scenarios include increasing levels of [...]
for or exceed the Track but [...]
the Big Creek Ventura fossil authorization f[...]

The analysis also considers the [...]
concerns in the absence of SONGS [...]
need by including three ORA Scenarios [...]
HSCE territory I are minimally [...]
the local generation requirement [...]
presence of increased generation in southern [...]
transmission improvements and [...] ORA [...]
Scenarios an additional SCE MW [...]
model[6] and in the other two ORA Scenarios [...]

---

[3] It is notable that these scenarios, with higher levels of EE, DR and PV – and all other ORA Scenarios - contain no explicit assumptions for increased storage resources (e.g., up to 1,325 MW that may come to fruition by 2022 as considered in the 9/3/2013 Proposed Decision in R. 10-12-007), other than the 50 MW of Track 1 resource authorized in Decision 13-02-015.

[4] See D.13-02-015, Ordering paragraphs 1 and 2 at pages 130-131.

[5] The Plexos model contains separate locations for SCE, Pacific Gas and Electric Company (PG&E) Bay, PG&E Valley, and San Diego Gas & Electric Company (SDG&E).

[6] We make no recommendations here about additional Track 4 needs. We run this Scenario to allow the Plexos modeling to explicitly account for the presence of another resource. We structure this resource as a 500 MW GT in the model but it serves only as a proxy resource available to meet peak period needs and

greater levels of distributed generation and
improvements but no explicit additional Tr

Q Please summarize your modeling results

A Table below summarizes the key results and includ
for comparison the CAISO s runs of Scoping

doesn't imply that a GT is required to obtain the available capacity represented by the proxy unit. To the extent that Track 4 results in additional resources deployed by 2022 beyond the case assumptions we use, the results of our Track 2 modeling runs will underestimate the system headroom, or exaggerate any shortage finding.

Table Summary Results PlRe Ax oSsc eHnoaurriloys Modeling uly

Scenario	Modeled Peak H (or Head	oDuurr aSthioornt aogfe rsohoomr t aHg e IHhouMrWs	modeled Comments days I
CPUC Scenarios Executed by CAISO			
Base			
TPP HOct [7]	Revision I		
High D DSM			
ORA Scenarios Base Load			
Shift DR Avail			DR p m instead of a m
Shift DR Avail and High DR			High DR smpShift DRoAvail
Hi PV			
Hi PV and Shift DR Avail			
High EE			
Hi EE Hi PV Hi DR Shift DR			
Shift DR Avail and Relax SCE Import			in area gen SCE
Shift DR Avail and Relax CA Import			Use High D DSM case import limit
MW Addition Shift DR Avail High DR Relax CA Import			Add MW SCE Track proxy
ORA Scenarios - TPP Load			
Mid EE DR and DR Avail and mid PV HSept TPP inputs posting I			

Notes

Track fossil resource naott Bciogn sGrdeeerke dV einnt utrhae s eH rsuhros r t a g e To dteMcWr dea xsitse n surpluses increase I by this amount

CAISO scenarios exclude fany mpTr e fa e k r e d erxecseoputr cteo atuhteh sorreixtz eaetntiaosn st u minps t ipoanr the Track scoping memo

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[7] Initial TPP results provided in the Aug 26th, 2013 LTPP workshop showed 5,359MW of shortage with a duration of 16 hours over 4 days. Afterwards, CAISO updated the model with new demand response assumptions and updated minimum and maximum capacities for some generating resources.

Q Please explain the detailed results se

A Table shows a generally ... amounts from CAISO s base ... consider any effect of Track ... model[8] in ... amount assumed in the CPUC scoping ... demand response resources are ... hour window namely from ... modeled shortage level declines

In scenarios using the base ... DR availability the shortage ... ORA Scenario H high EE only ... tightest hour of the year ... D DSM scenario

Q Does shortage imply a ... LTPP cycle

A No As seen in Table ... testimony the shortage values ... shortage indication suggests ... approved resources and project ... as the system may need for ... all the details inherent in the modeling sys

The details include outage ... capability limits on RPS ... renewable resources that ... possible I maximum DR potential ... assumptions

Q What is your opinion on ... the detai

A In our opinion it is ... parameters over time will ... meet shortage needs in rack ...

- Outage rates for supply resources ... day could decrease as California ... ancillary service incentive ... and the CAISO markets Current ... service in California in ... nd
- As Track solutions are ... transmission upgrades I and ...

[8] CAISO has stated that they have excluded the Moorpark sub-area of BC/V fossil resourced, and preferred Track 1 procurements.

WECC balancing[9] maximum simultaneous transmi[...] into California or the CAISO balancing ar[...] currently modeled in the Plexos environme[...]

- RPS requirements are not likely to dip be[...] increase and even in the [...] beneficial reasons for more RPS energy to [...] commitments suggest [...] available capacity during [...] currently mode[...] incremental flexibility [...] using high levels of PV [...] of solar PV resources or wind resources [...] other resources to be available at the time as capaci[...][10]
- Demand response HDR I potential high DR li[...] levels from the[11] Scenario Tool for the I [...] load reduction that may be needed
- The IEPR already shows a lower peak [...] mid case than the IEPR showed [...] extent that load growth trends continue [...] residual procurement needs [...] LTPP wil[...] planning cycle all else equal

Q Please summarize your conclusions

A We find that deploying preferred resources [...] will ensure sufficient system flexibility [...] renewable resources. In our opinion, no a[...] conventional fossil fired generation [...] shortage is minimal and [...] resources that could be available [...] particular targeted levels of demand response [...] DR cases that need be available on a very [...]

Lastly we note here that the [...] existing OTC units scheduled for retirement [...] underperforming preferred resources [...] OTC [...] without any date extensions are reflec[...]

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[9] WECC – Western Electricity Coordinating Council. Federal and regional initiatives will continue to improve coordination and transmission system utilization efficiencies across the western region.

[10] Our modeling results account for any unit commitment effects that may be present. Those effects could, in theory, lead to de-commitment of resources in the day-ahead time frame because of solar PV or wind resources meeting need in certain intervals. But our modeling of high PV scenarios does not increase the amount of shortage seen in those intervals – shortage is decreased.

[11] The current "high" level is 2,963 MW; mid-DR levels are 2,595 MW. Scenario Tool, v6.

TRACK 2 MODELING

Approach

Q What is Track modeling

A Track of the LTPP Prooits sfyocsctuesmed as opposed to local resouracrees siunf ftihcei eCnatl i support the State s goal of dcebmtaanidning Track modeling consists of analythicaddlitey teoset ai lmating resources will be needed in taking itmotcbaalcancc a myriad of system operational details proje

CAISO uses Plexos a detailetdh ihsoaunrallyy scibost p Synapse uses Plexos in suppdoritc aolf stthreu cOtRuAesc Plexos Hin short hourly dti sIpaitsc hi matnedn daesds o capture the capability of tenahivwidludal I Hfeasndui provide energy and required yoepaerr a t i nTgh orsees e r v resources include all supplfyo arnCdaldeim faonrdhi a s i d consisting of multiple typesu noift sg eunseirnagt i n g a different fuels and imporets se r v e hteeadlsdoi ance hour to balance out within nhdo u r fTlhuocsteu aatrieo n referred to as Step iThhpeu tPsl extoo s t hmao dPelei method is intended to capturrec et hoeu thpouutr a st o t h aggregate of all resources acreossseedatcbh dhaeyto the year

In order to properly accounett floora dt h e tphoet ePnlt ei model includes a detailed rEeplreecsternitcaitoy n of Coordinating Council HWECC plal uitnicllliutdiiensg C A loads and resources outside of the state

Q Please explain your approbatcoh irmunusin gO R A Scenarios using different acnomnlthiionsæt iuosnesd cbfy CAISO

A Synapse obtained a licemvseendforrom Eanmedrgy used the same version of tShyenapsose ftewaxreecutse dusse monthly model runs for difsfer efnotc ursei snogu rmcoes on uly as this is tihne CmAoInStOh esx heixbeict of the base scenario We xreacnu taimonmusa lf o rHit hee TPP and High D DSM cases and faovraiil oanbeilOiRtAy Sce shifted to the window pp mm towinpdowm utilized by CAISO in their runs

Q Please explain how you obmtoadienlediGng and us

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[12] PLEXOS 6.208 R08

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our results to be consistemutst weidthinCpAaItSO s r
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scenario as specified in theelCPoUfC isnccorpeimegn tmae
PV resources We used theifiehdgihn thiencCrPeUnCe
Scenario tool to form the ORnAcrsecmeenatrailosPV i
did the same for the incremesntal EdEr aesxsaummpltei
the TPP case starts out with aand wleowusedimacre
mid incremental EE assumsptwiiotnh ftohre tThPeP ORA
forecast We explain the hOeRAn eSxctemsaercitoi oans su

Preferred Resource and Other Assumptions – ORA Scenarios

Q What are the ORA Scenarios

A ORA Scenarios are differsenutsecdombinatio
defining alternative Plexos swceernearrnuons for eonne
month in the Plexos modeling weenrveirounmmefnotr t
some cases We show shortagueldyhelardotoympivcaallu
most constrained month Fmoornt fhosuroFscenarios
order to develop full year udruncreatsihoonr tcaugreveosr
headroom over the entire yeasre TThPeRse sacrecheaHr
D DSM cases as well as theilORtAy Swcienndaorwioofad
demand response resources

Q What combinations of prefoedrerlediimretshoeurc
ORA scenarios

A We model different levewloos roflaEXEed DR a
transmission import limit smpeonratrilosmit owneas wh
increased MW to haMvWe and one wh
local generation compared tCoA aimdpeofratullti maists
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D DSM case The SCE localasgeanesreantsiiotnivaitty
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generation from meeting lesaspptlhiaens a penadftyi
violation amount Has part ooff vtihoelaptriodnuclt iiofn

[13] We note that CAISO has stopped enforcing the SCE in-area generation minimum of 40% as of October 1, 2013. http://www.caiso.com/Documents/TechnicalBulletin-ImportLimitDefinitionandManagementinSupport-Under-FrequencyLoadShedding_UFLS.pdf.

model does not have sufficimeondtelindemaameda gene
a response resource availabilityp mshifteidchsteta
a m to p m window uatriilaibzleed cbhya nCgAeIsS O
different combinations makbelup thbeelsoewt loifs
combinations modeled

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Table ORA Scenarios Assumption Parameters

	Inc Uncom EE	PV[14]	DR Capacity HMax	DR Capacity IH p	DR Avail Window m I	SCE Import Limit	CA Import Limit	Track or Fossil Addition
CPUC Scenarios as Run by CAISO								
Base		MW	MW	MW	MW			
TPP		MW MW		MW	MW			
High D DSM		MW	MW	MW	MW			
ORA Scenarios – Base Load								
Shift DR Avail		MW	MW	MW	MW			
Shift DR Avail and High DR		MW	MW	MW	MW			
Hi PV		MW	MW	MW	MW			
Hi PV and Shift DR Avail		MW	MW	MW	MW			
High EE		MW	MW	MW	MW			
Hi EE Hi PV Hi DR Shift DR		MW	MW	MW	MW			
Shift DR Avail and Relax SCE Import		MW	MW	MW	MW			
Shift DR Avail and Relax CA Import		MW	MW	MW	MW			
MW Addition Shift DR Avail High DR Relax CA Import		MW	MW	MW	MW			
ORA Scenarios - TPP Load								
Mid EE DR and DR Avail and Mid PV		MW	MW	MW	MW			

Source CPUC Scenario Tool v Synapse

[14] Incremental small PV.

Q Please discuss the levehle oOfR Apreferred
Scenarios

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in different combinations aratmhet eErEs PVFor DOR
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internal generation minimum HI I aOnRdAe C
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for a Track resource addiilt aiboinlityalongswing
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retained the TPP gross load aDsRs umpatnido nDRbut n
availability values to refdl ehcotu rmsi df orc aDsRe HE
availability

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availability

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shortage hours

We shifted the hour window pfromm
for SCE and SDE s DR resouracrees nottonerceecsoganri
limited The IOUs tari fef sunraevaeiala btlheatafvte
p m The Commissione vsahlouualtde dtihreect
potential load drop capapbriolgirtaymsofi nextihseti
p m p m tinmlefpruamnpe nAottoar mi
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resource system operates i fnsgucvhalDuRe wexriestasvai
showing how the overall systeamn dr etahcitss DRo cha
parameter in particular hasoartdgemadturicngf fthe
key late afternoon early evening summer pe

Q Please describe in detaeial itmhpeorrtevised
capability

A The production cost modelatwalseassett to r
the power required to serveesits albovade fwohimcShC
significant cost was imposed toWeaaldgjuesttheed
model to take further advanftaagre aosf alvoawi lcabslte
this sensitivity We makeathisheasefinpttonn

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shortage levels on the SCE ... transmission reactive support ... operation with greater levels[15] of imports int...

Q Please describe in detail the ...

A We used the higher CA import ... High D DSM case which was ... MW in ... MW We presume that this increase ... from the presence of greater amounts of ... D DSM case We also use ... MW of additional generation ...

Q How did you determine which permutatio...

A We wanted to illustrate three ... variables on modeled surpluses ... might be considered something ... introduce greater levels of ... MW during the shortage hours ... levels of PV the dispatch ... be needed when those higher levels of PV are ...

Our selection of the next level up ... mid I is intended to show ... procurements of preferred ... California s energy policies ... meet energy needs which ... EE DR and distributed ...[16] ... this context we support ... before contemplating the procurement of conv...

MODELING RESULTS AND PATTERNS OF SURPLUS/SHORTAGE

Load and Resource Output Patterns

Q What does the CAISO region ... base case the shifted DR ... levels of preferred resources ...

A Figures through below show ... day for the CAISO region ... also shows the projected load ... p m on that summer day ... roughly MW between these hours

[15] As noted, CAISO has stopped enforcing this minimum generation restriction as of October 1, 2013.

[16] *Energy Action Plan II,* p. 2.

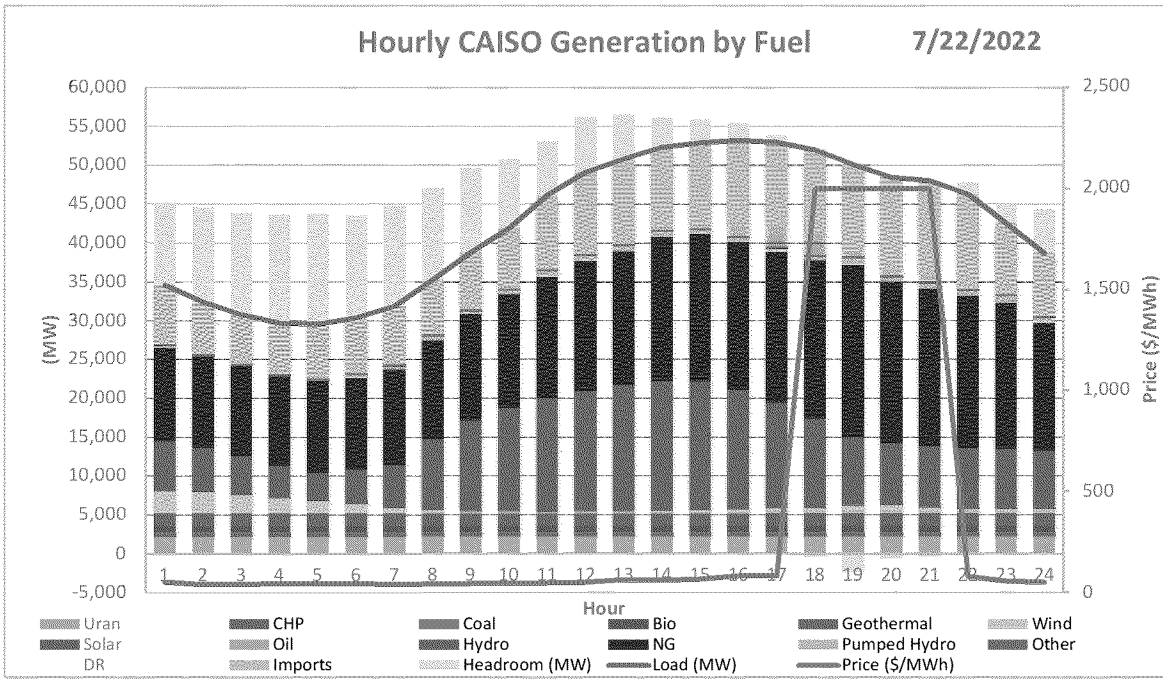

Figure 1: Hourly CAISO resource output, headroom, load, and price July 22 2022, CAISO Base Case

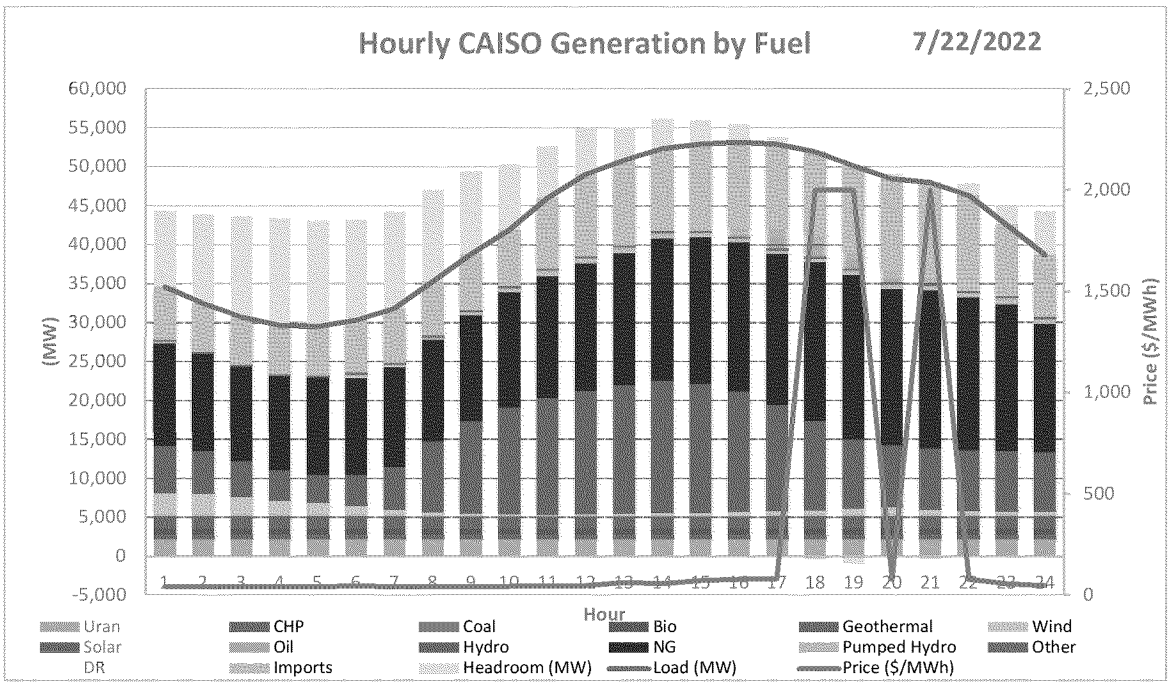

Figure 2: Hourly CAISO resource output, headroom, load, and price, July 22 2022 Base Case w/ Shifted DR Availability (ORA Scenario 1)

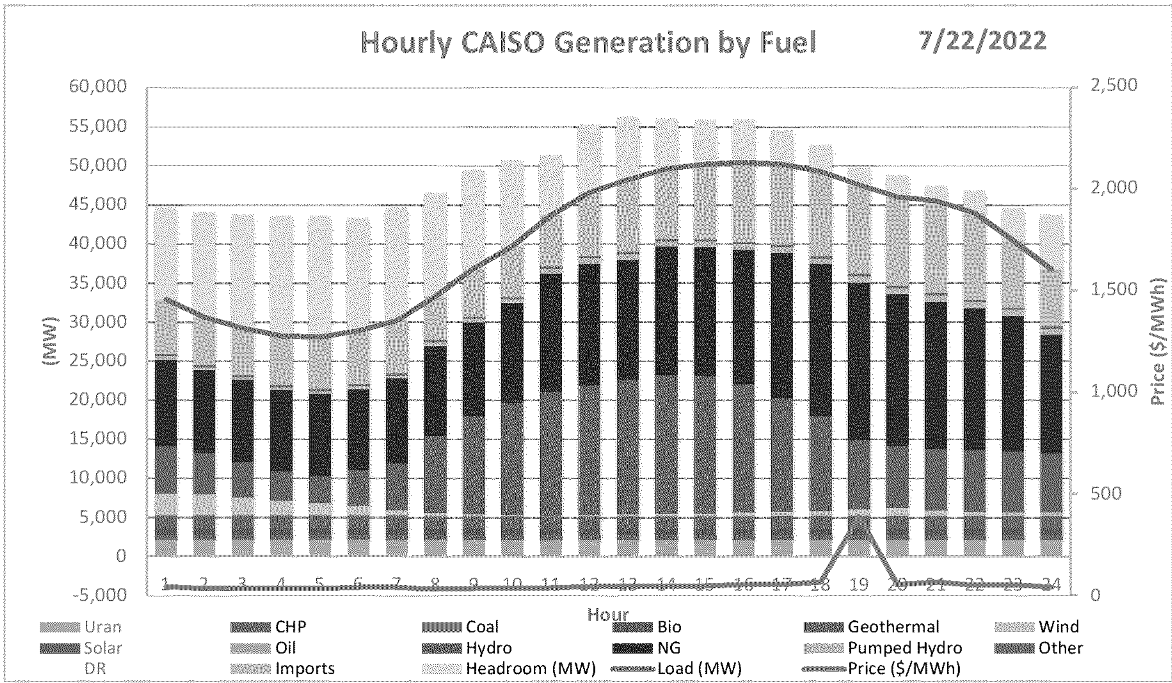

Figure 3: Hourly CAISO resource output, headroom, load, and price, July 22 2022 High Preferred Resources + Shifted DR availability case (ORA Scenario 6)

Q Please explain the patterns shown in F

A Figure illustrates the existence of base case of four hours hounds H top The bar I and the price spike effectively serves M proxy for shortage in those hours of demand I Figure is shifted out to PM hours while there is significantly lowered from the base case MW al shortage at p m I The shortage totals hours shortage In Figure day when high levels are available along with shifted DR, the stacked bar exists in all the hours on early evening hours H MW headroom is shown as tight price spike in the tightest hour lower than the hou proxy price associated with a shortage

ORA Scenario Modeling Results

Q What are your summary results from Tra

A Table lists the key results of ORA Scenarios and includes CAISO results for the High DR Scenario

---

17 This result is an artifact of the specific hourly outages for the day, along with the combination of other resource output and load at those hours.

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Table Summary of Modeling Results for Highest Shortage

	Scoping Memo CAISO Runs			ORA Scenarios									
Scenario Name	**Base**	**TPP**	**High DG/DSM**	**Base modified 1**	**Base modified 2**	**Base modified 3**	**Base modified 4**	**Base modified 5**	**Base modified 6**	**Base modified 7**	**Base modified 8**	**Base modified 9**	**TPP modified 10**
Scenario elements	**Base**	**TPP**	**High DG/ DSM**	**Shift DR Avail**	**Shift DR Avail and High DR**	**Hi PV**	**Hi PV and Shift DR Avail**	**High EE**	**Hi EE, Hi PV, Hi DR, Shift DR Avail**	**Shift DR Avail and Relax SCE Import**	**Shift DR Avail and Relax CA Import**	**500MW Track 4, Shift DR Avail, High DR, Relax CA Import**	**Mid EE/DR and DR Avail and Mid PV**
Metric													
Extreme Hour													
Shortage	H	I	or										
Headroom	H	I											
Duration of shortage days		hours											
Peak Load	Base	TPP	Base	Base	Base	Base	Base	Base	Base	Base	Base	Base	TPP
Increment	Mid	LEoEw	High	Mid	Mid	Mid	Mid	High	High	Mid	Mid	Mid	Mid
DR Availability	P	A P	A P	A P	P	P A P	P	P A	P P	PP	PP	P	PP P
Increment Event based DR	Mid	Zero	Mid	Mid	High	Mid	Mid	Mid	High	Mid	Mid	High	Mid
Increment	Mid	ZPeVro	High	Mid	Mid	High	High	Mid	High	Mid	Mid	Mid	Mid
SCE Import Limit	No change									area	in gen	No change	
Duration of Modeling Run	m	m	m	m uly	uly	uly	uly	uly	uly	uly	uly	uly	uly

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Q Please explain the results in Table [illegible]

A In general Table [illegible] most extreme period in [illegible] preferred resources He g d [illegible] for demand response resour[illegible] procurement of mid to high [illegible] more than four hours over no [illegible] base case I For cases with [illegible] shortage magnitude and durat[illegible]

Q What do the results show [illegible]

A The results first show [illegible] with reasonabl[18] [illegible] critical hours on peak days [illegible] a maximum hourly shortage of shortage [illegible] MW is [illegible] seen in CAISO s base run [illegible] total duration of shortage [illegible] combinations of increased [illegible] for all other variables [illegible] duration For ORA Scenario [illegible] procurement the shortage values are [illegible]

ORA Scenario shows the [illegible] H MW CA import limit [illegible] window The addition of [illegible] MW of [illegible] with high DR and shifted DR [illegible] limit reduces the shortage to MW

Q What do the results show [illegible] for the TPP

A We ran one scenario using [illegible] but modified for preferred [illegible] resource inputs and retain [illegible] modeled shortage drops to MW

Q What do the results show [illegible] High

A Based on the High D [illegible] mitigated with signific[illegible]

<u>Patterns of Surplus/Shortage</u>

Q What do the modeling res[illegible] over the course of all hours of [illegible]

A The data show that the [illegible] prevalence of solar resource[illegible]

[18] No defined limit exists on the ability of DR resources to be available after 5 PM.

SB_GT&S_0130563

evening rather than mid raif tt iecr anlo opne raiso dh a s bF
below shows the annual patt ehren boafs eh ocuarsley s u rFpi
shows this annual pattern awshi acth soartvasi lt ahnlei ldiatt
according to magnitude of shortage or surplus

The annual duration curve an ddatthae sHei qnu etnhteisael g
for the CAISO base case I beo tfho ri ljl uusstt raa tceo utphlae
modeled hours over the count sesof hthaes ea fifi rceiey
exists across the Californiae ssey stther mee vcerni twictahl
considerations i I RPSe tii ir elmeonrt c de vteHlrs
SONS out of service The feummadnadmedne tmaoln sptartatt eer
relative robustness of resource adequacy for

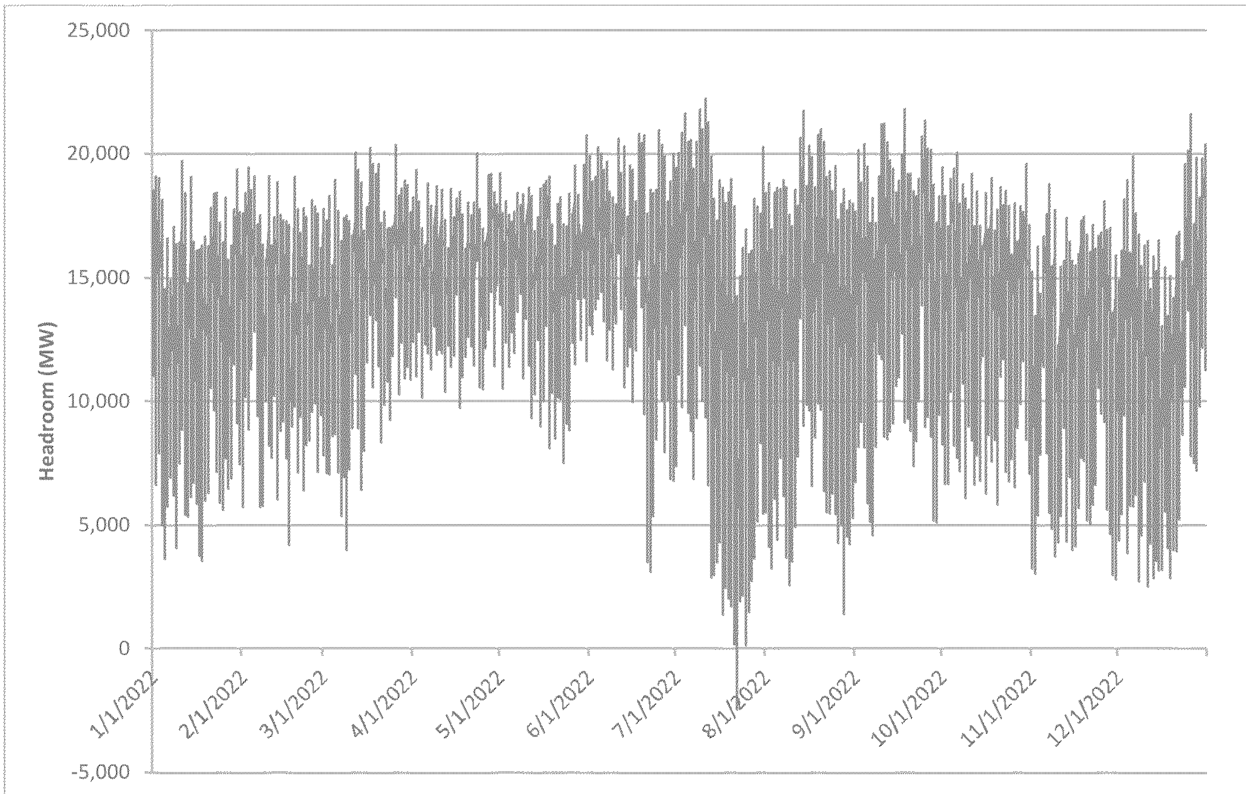

Figure 4: Annual headroom under the Base case assumptions, sequential hours of the year

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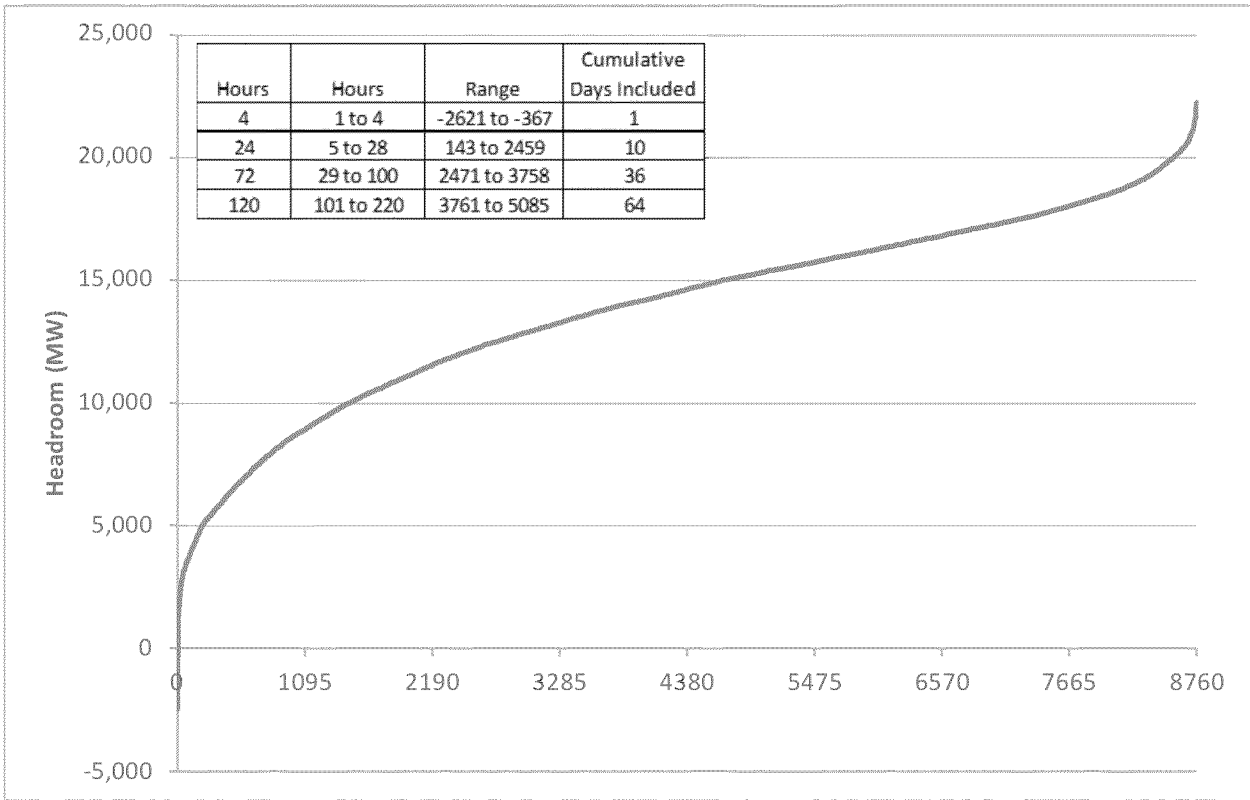

Hours	Hours	Range	Cumulative Days Included
4	1 to 4	-2621 to -367	1
24	5 to 28	143 to 2459	10
72	29 to 100	2471 to 3758	36
120	101 to 220	3761 to 5085	64

Figure 5: Annual headroom duration curve under Base Case assumptions (headroom +, shortage -)

Notes

Positive values are surplus at H sheadroom I nega
hours in the year

Inset table hours firstorctoal guemnoriss utrhpel unsumbetrheof
hours indicates where thcousrevehours Thfealtlhiirnd tchoel us
the shortage H I or surpmluumsberHof I rcamnggleaftoirvetho

Q The annual duration curve hwavsef 6ri gtuhes CA
ORA Scenarios

A Yes We developed a set[19] aonfd gsrhaoprhtsa gfeor
duration for the ORA Scenarios

Q What do the shortage heaSdcreonoamr ipoast terns

A Figures and show thyese pCaottmemronnst feo
emerge among the ORA Scenarioosom inTheeasceh chuoruvre
sorted from lowest to highewsetl vAalluedse rsAbdsc
phenomenon that during the vaasts umbasjtoarnittiyal ofamho
headroom There are only a tfaegwe hmoauyrr sexfiosrt whiA
scenarios with adjusted timimvgs ufbsdtaamtaindtlreyspl
shortage Hupwards of hMWrosf threadhuicesd ost
seen if the timing is lefctemasrioss iwnitthheh iCgAhI SlOe

[19] Headroom is defined as Available Capacity + Imports – Load – Reserve Provision.

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energy efficiency additions at a rate in a MW of the headroom
hours

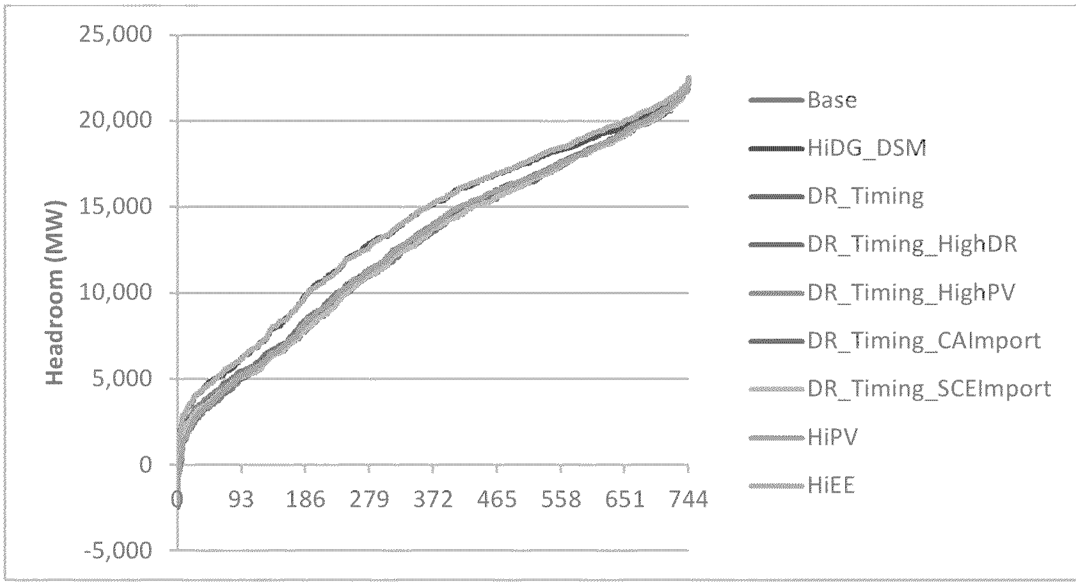

Figure 6: July 2022 Headroom Duration Curve (all hours)

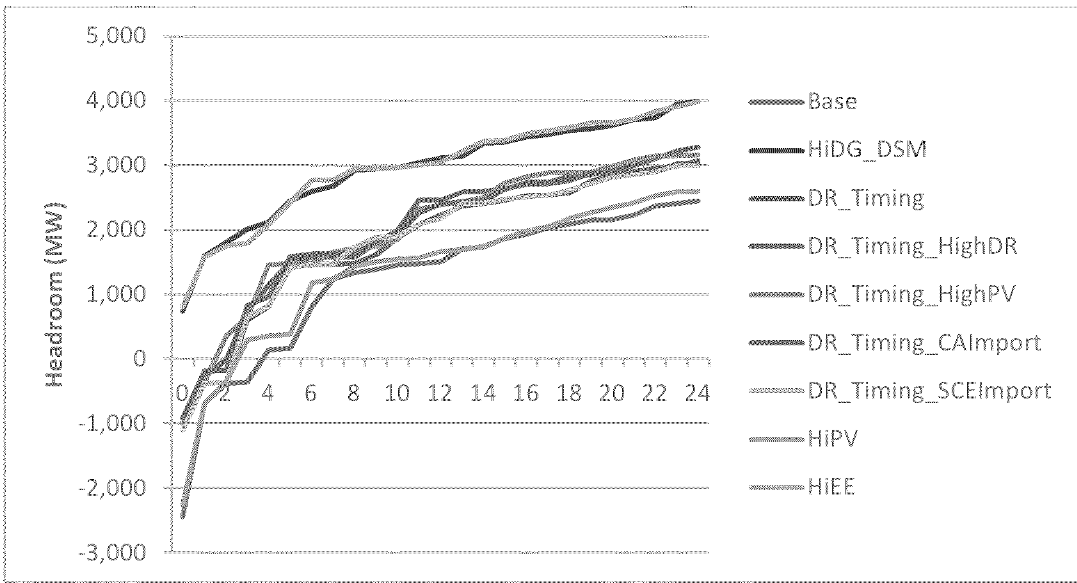

Figure 7: July 2022 Headroom Duration Curve (top 24 hours)

Patterns of Preferred Resource Output

Q How do the hourly PV patterns align with

A Solar PV facilities are distributed ... terms of consistent hourly output ... The

trend for both the peak daymonHtFhi goufreuly IHFingu
show total solar output peaukrisngofnesalromtoagne imA
case H pm and pmput ihsoudresclininagndr
there remains significant oruetspeuntt iantg p MnW
MW with high incremental small PV assumpt

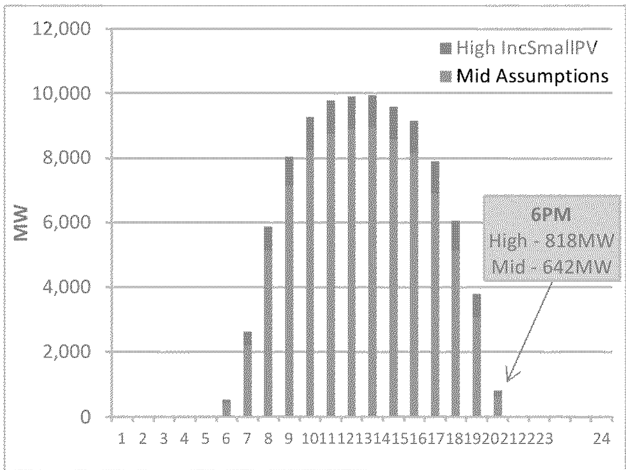

Figure 8: July 22 CA Solar PV output

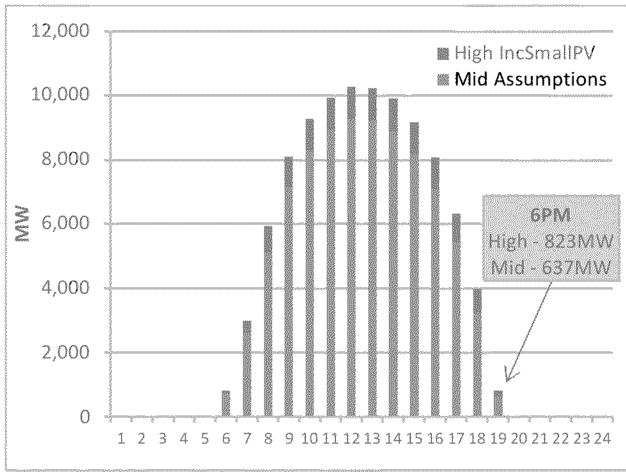

Figure 9: July Avg CA Solar PV output

Q How do the hourly wind pattagens align wi

A See Figures and flaelidwitfiers wildk
facilities are also disterisbountee dbetnherfoiutgshoiunt t
consistent hourly output atsya rAsluhtrgeof tlhispa
between the peak day critiatalthaoturcruitpcutal al
uly nd at pm cMdWurosfe wdifndthies maovmat
average of MW wind output is seen at

To some extent the tighteisst dduaey in pualryt to mp
Hi e modeled I lower loattipwuet todf tthlee ualgygra
during this critical late aifntFerignoorne earlyl eve
to recognize that stochastic iannatlhyissi sTrbaecykond
analyze the extent to whichoulroswedurwiimngl tohueppuet a
summer months occurs concurroetnatbllye *atvieihrgaeg*nt ptehaek l
pattern during uly Has seonriampFiugpurfersom midad
while solar output is ramping down

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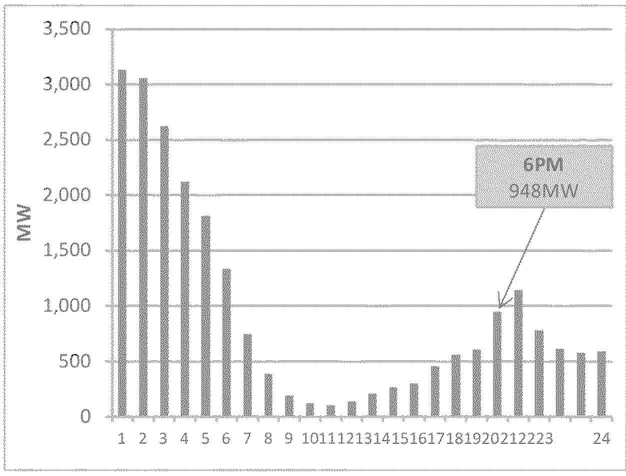

Figure 10 : July 22 CA Wind output

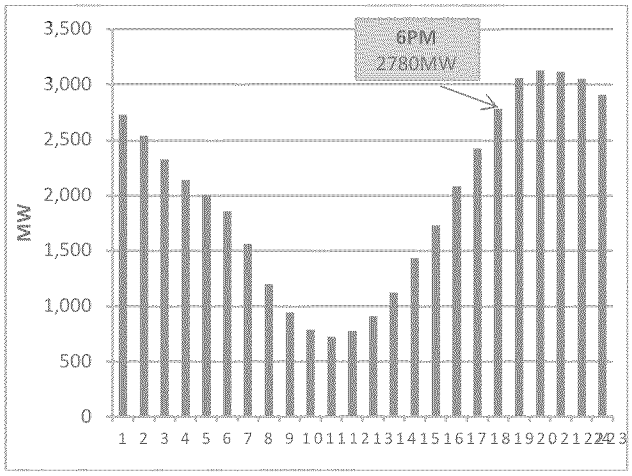

Figure 11: July Avg CA Wind output

Q How to the combined hourh yt hwei npde rainodd ss ool fa shortage

A Figure shows the comb k n d d y wind O n t h e day at the critical hour w i s n d n t a n d solar M W s in the base case and s o u M W e w h e r e h u g e d i

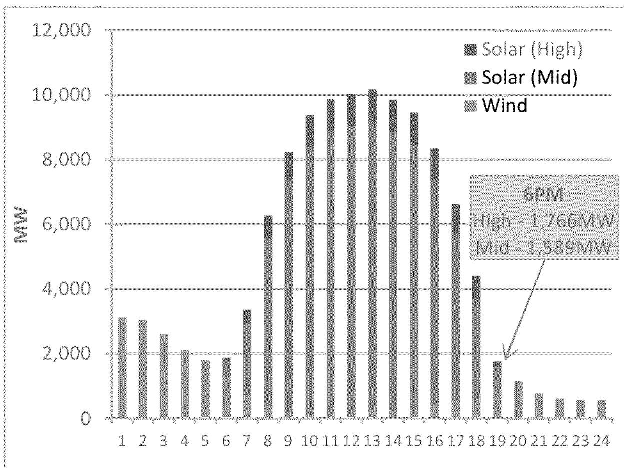

Figure 12 July 22 CA Wind + Solar Output

Q How is DR utilized throughout the month

A DR is only actually ca l w l h d u n p o n[nd] f o t r h y e n e day of identified shortages i g n t h e c h a n s k y c n e d u c amount of DR that m [nd] u s t f b r e o m c a l l t e o d t a d n o u f l y total usage

Throughout the month DR i s u s e d a p p r o x i m a t e l y MW in the hours between noon s h a n d t h e p a n

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DR output during all of ulyCAI SaOn db aosne jcuasste tahned selected ORA Scenarios

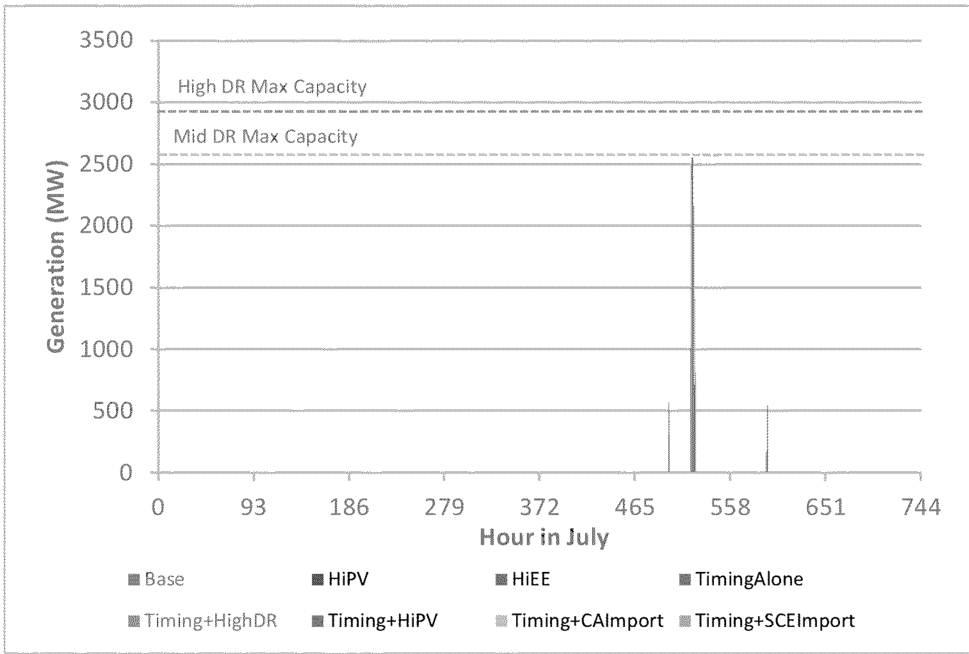

Figure 13: DR Generation in all hours of July

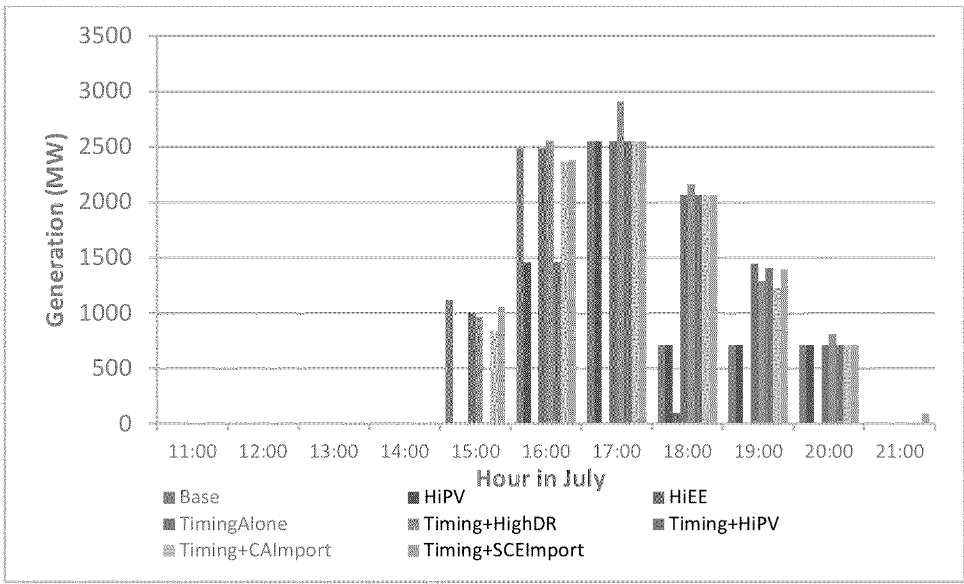

Figure 14: DR Generation on July 22

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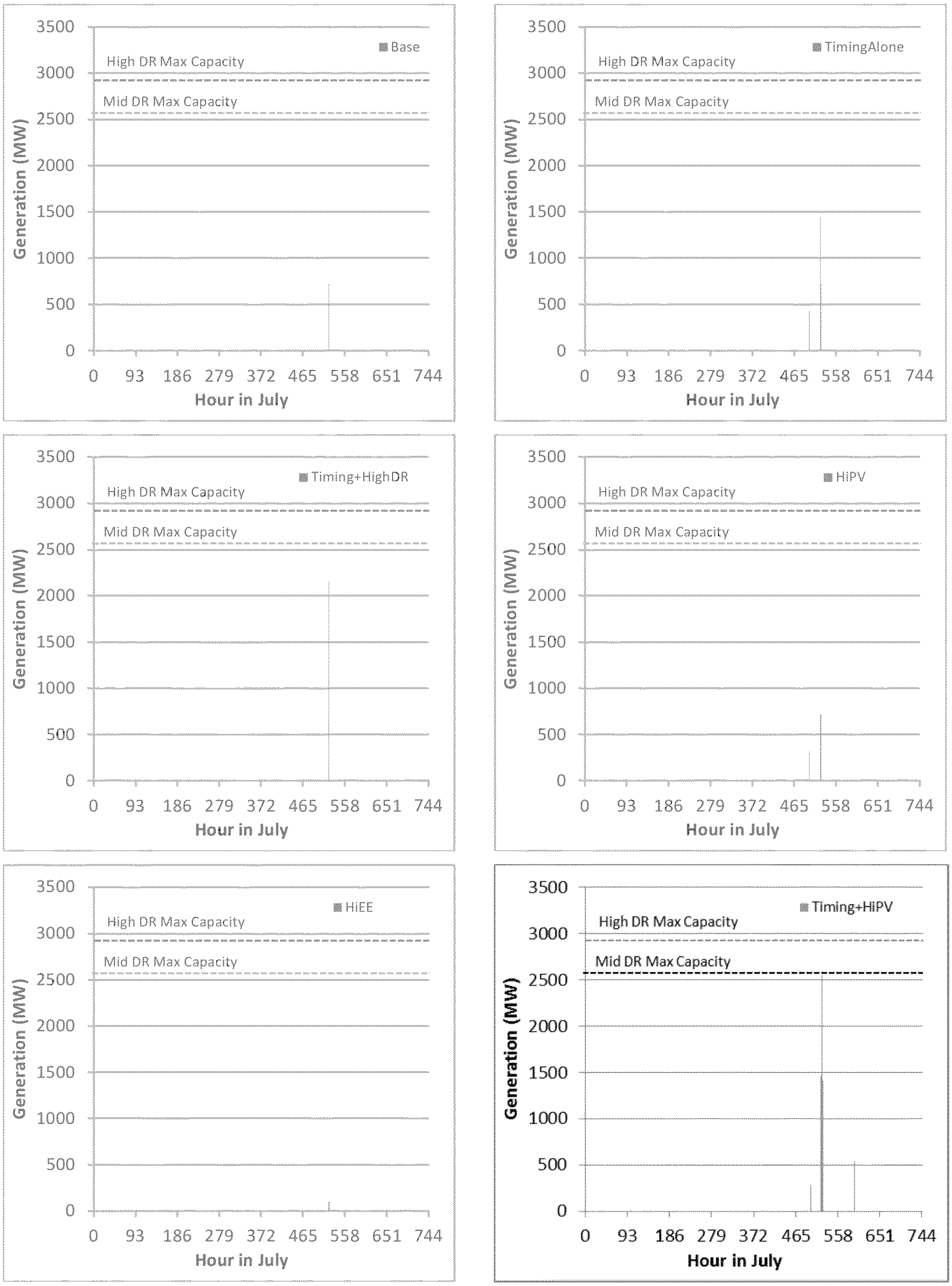

Figure 15: July DR utilization for selected ORA Scenarios

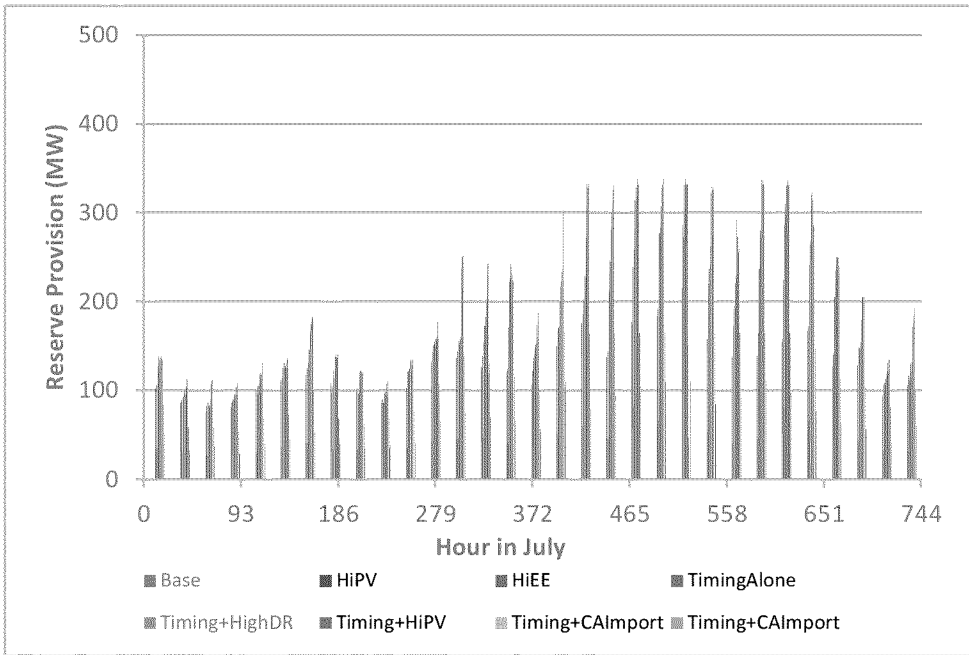

Figure 16: DR Reserve Provision all hours of July

As is seen in Figures t hurpo utgoh maximum mo no uctrp
the critical hours limi tedel l ins thinepbtase conss tena
reduces DR output after fp DRm unTchers s t a mcdal b
that prices spike higher durilnigs tcraitteiscat hheocuri
that limited use resources reedspable ali s l y s tDeRm op
during the extreme stress peortieo dtsh afto rt htihse emxotdr
stress occurs on just one day in the modeled

As seen in Figure DR prorvigiedsesenotgiahlyg a
afternoon daytime hours of the month

<u>Resource Outages During Peak Summer Month</u>

Q What resources are not asvuamilmaebrl emodntuhr ingu
the base case Please comment

A Total modeled outage levels in MdWy vaTrhye
where shortage thourosutwaegr es epveiadkenpat m when MtWh
is highly constrained thifsori sRAr epqdeurfeodr mtaonce
reduce projected summer peak month outages

Several major units are outodeml ithneg peiankcl duadyi nig
Palmdale High Desert andn EtlheeS eSgCuEn dtoe rritcon
Unit at La Paloma in P Eatnedr rrietsoruyr ce fiovreen

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coupled with[20] RA incentive to reduce outages these four of capacity that when combined with improves could eliminate the shortage on July

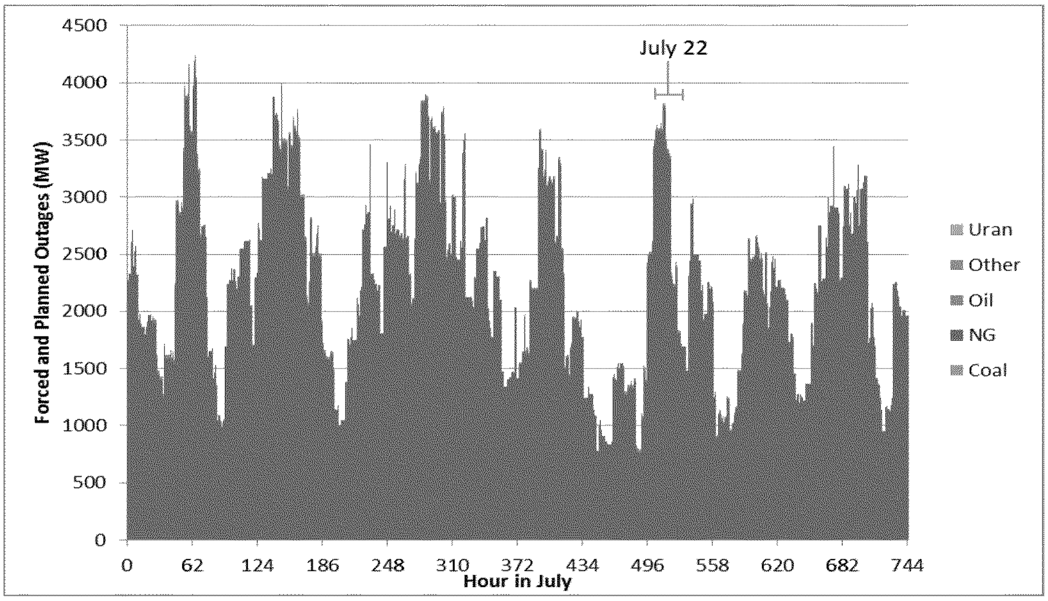

Figure 17: Modeled CA Outages in July 2022

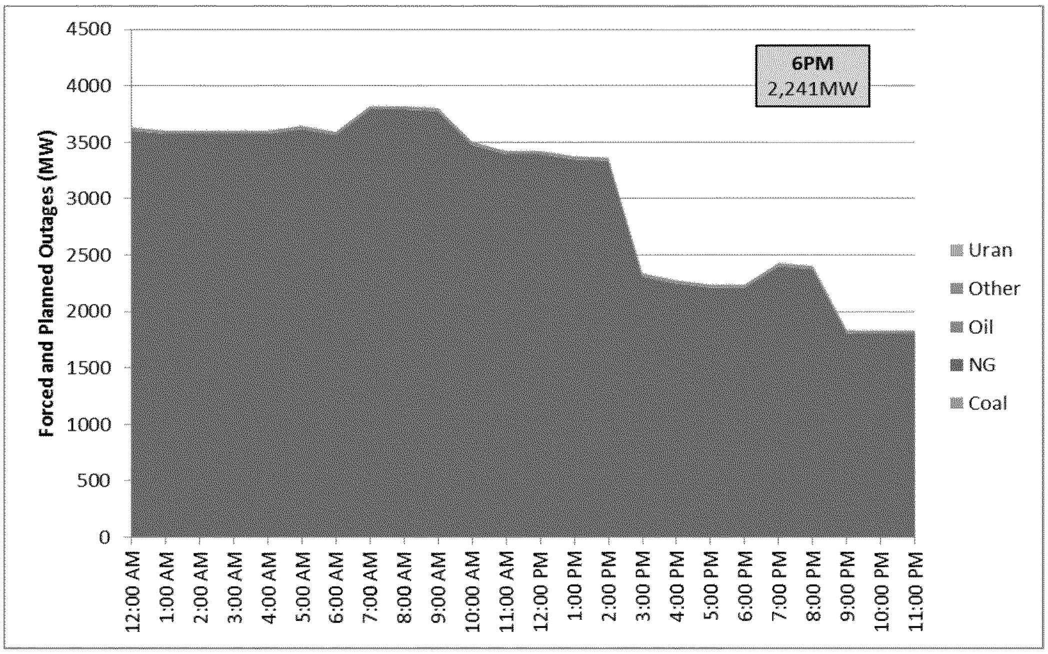

Figure 18: Modeled CA Outages on Peak Day (July 22, 2022)

[20] The RA construct is undergoing possible change to incorporate the value added of flexible units, and possibly increasing the RA obligation period beyond 1 year. Those changes could increase incentives to improve performance during peak periods.

ADDITIONAL DISCUSSION

Procurement Timing and Mechanisms

Q Is advance procurement [illegible] based on the Track [illegible] analyses you [illegible] conduct[illegible]

A Both preferred and fossil [illegible] ensure their deployment when [illegible] number of variables. Cont[illegible] resources is sensible [illegible] though [illegible] the LTPP process could better secure their ev[illegible]

Advanced procurement of foss[illegible] order I would only be needed [illegible] if [illegible] the resource need [illegible] resource procurement was likely [illegible] b [illegible] there was no mechanism in place [illegible] beyond those modeled as [illegible] Tables [illegible] and [illegible]

Neither of these conditions [illegible] shortage amounts is not [illegible] for a few hours on the extr[illegible] otherwise to obtain additi[illegible] shortage.

Those mechanisms include depl[illegible] is reflected by the inputs [illegible] resources for very infrequen[illegible] available from existing unit[illegible] is reflected in the model [illegible] that could lead to new pla[illegible] and ancill[illegible]ary market[23] [illegible] existence of the resourc[illegible] IOUs[24]

Base Case vs. TPP Forecasts as Basis for Procurement Decisions

Q What are the key differe[illegible] assumptions

[21] CPUC decision on Track 2 in 2014.

[22] OTC resources retire by 2020.

[23] Those markets continue to undergo refinement to reflect the increasing value of capacity that exhibits flexible operating characteristics. Such refinement includes CAISO's changes to the energy market to incorporate a flexible ramping constraint into the unit commitment and dispatch provision, and changes to intertie scheduling timeframes in accordance with FERC's Order 764.

[24] The RA construct is also undergoing possible change to incorporate the value added of flexible units, and possibly increasing the RA obligation period beyond 1 year. Those changes would increase incentives for market-based development of new resources.

A The TPP and base case used different ... load[25] I incremental EE projections ... assumptions. The TPP scenario uses[26] a ... in the base case forecast load f[27]orecast. The TPP case uses a low incremental ... base scenario uses a mid incremental ... The TPP and ... cases use the same projections of ... Hboth PV and non PV I ... combined ... projections for gross load ... managed net demand MW higher ... than ... base case ...

Q Is it reasonable to consider the higher ... when assessing procurement needs

A Possibly This element ... sensitivity to the base case ... demand ... However ... procurement decisions for system needs ... peak

Q Is it also reasonable to ... consider ... PV ... TPP does

A Yes but again as a ... the TPP case ... of these elemental differences ... extreme sensitivity ... base ... the base case

Q Can you comment on the ... decisions on either the base or the TPP case

A Yes The in ... peak ... system capacity need determination ... peak load ... The Resource Adequacy program ... margin which in part ... Commission s use of a ... capacity requirements is ... peak load However for system ... more than a in peak ... because it is unlikely that ... CAISO region load areas at the same time

Track 1, Track 4, and OTC Retirement Assumptions

Q How are assumptions concerning new ... consideration in Track reflected in the T...

[25] This is the term used in the CPUC Scenario Tool spreadsheet.

[26] Form 1.5c.

[27] Form 1.5b.

A Some of the authorized Track 1 resources are reflected in the CAISO modeling. Notably, Track 1 excepted preferred resources are present in the modeled assumptions. The Track 1 authorization of gas-fired resources are considered in CAISO's (ISO) sensitivity scenarios with greater levels of preferred resources. Table 4 below shows which Track 1 authorized resources are included in Track 2. No resources potentially available for Track 2 are included, except in one sensitivity scenario. CAISO's scenarios that may be authorized can be subtracted from any Track 2 resources, as the Track 1 authorization. Other results from transmission planning process (HTPP), efforts in studies support that the California import limit, imports from external systems can directly make up part

	CC	CT	Storage	Track 1 Preferred Resources
SDE				Excluded
SCE				Excluded
Big Creek Ventura	Excluded	Excluded	NA	Excluded

Table 4: Track 1 Resources reflected in the Track 2 Modeling

Q How are OTC resources treated in the CAISO modeling?

A All OTC resources are assumed retired on schedule; any potential extension of retirement date is con

Q What effect could an extended retirement date

A Any extended retirement dates reduce any Track need by roughly the level of output o

Q Please discuss the role of extension of OTC plants.

A Extension of OTC retirement dates could be a cost avoidance measure for the CAISO generation in most scenarios with successful procurement of units with an extended retirement date. Total air emissions from OTC units would likely be very low as they generally ancillary service requirements.[28] OTC retirement a bridge to a period when emission compliance

---

[28] The California Air Resources Board (ARB) and the State Water Resources Control Board (SWRCB) may allow, or be more open to, an OTC extension intended only as an extreme day backup, with extremely limited or no cooling water withdrawals and air emissions. Certain OTC units could be fully offline (i.e., mothballed) for 9 months, available as a backup only for predicted extreme peak days during the summer.

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increases in preferred resour wouldavailmorebilitykel
place OTC extension coulackserve containgadrte
for gas fired resources neiaornsor atro SDannE asn
Park consi Therstitestsimony does not addthess t
alternative insurance policy vs other app

Critical Periods for System Resource Need

Q What do the modeling reosdulstfsorresvyesatlemoome
especially those periods whemt isflmeoxsitbiwaitryant

A As seen in the modeling resultstshe Habowse
sections critical periopseakrdealyiskelnythe bseum
the concern is essentially falgeinerlictycapraclitey
relatively broad array of rsessosuurcchescocnocuelrdnsbe
resources do not necessarily fieeadntcedbaensdpeplcia
construction to yearsamppingdvance flexTiheirl
during any base scenario perThoedreaxcreoptnonRAheo
whatsoever in the high D DSeMvesrcewaiatrhiothe cTdhricse
registered about spring afpterno[30]onsmoopdeerslidngs e
reveals that the system asdaiswhpbeeintsialctlyaslse
stressed Hbased on current epakojsecntmieonsolahdinhg
is understandable thereuipspolay rsiezsaolhlreegbasse
in CAISO and California to amdedrntess seyvsetnemwitlhe
retirements The main diffeconcerhetlwaetenish
in the base case modeling andrmordeRtAraditcieomas
the critical hour is shiftiedalahead a PMwpdhroiuroc
slightly later late aftewnotonpeajteydePVng
decline

Import Considerations

Q What statewide import limits are used i

A The model uses summer peakeCaAndmTPDPtcasoe
CAISO s high D DSM case usesbiandlsimaitt corfitical
contributes to the shortage in the key uly ho

Q What other transmission limits are used

A The imports into SCE andtedhteoiampforastiion
SCE service area total loadtedaianoetheomodel
violation occurs

Q Please discuss the import limitations

29 Track 4 testimonies of SCE and SDG&E.

30 Numerous presentations by stakeholders have used or cited the so-called “duck graph” when highlighting the potential late afternoon/early evening ramping concerns that may exist when the state has more solar resources online. For example, as presented by the CAISO during the February, 2013 en banc “Capacity Summit”.

A enerally the import [illegible] system to see zero modeled s[illegible] Scenario conditions without [illegible] improvements and or increased [illegible] requirements could increase[31] [illegible] Track need determination

California has always depended [illegible] maximize the utilization of [illegible] renewable integration resources in WECC [illegible] coordination[32] CAISO and CA as a whole [illegible] to increases in the overall [illegible][33] [illegible] CAISO to tap into existing [illegible] days and reduce potential [illegible] infrequent periods with tight system resource

CAISO Track 2 Modeling

Q Please comment on CAISO [illegible] of Track

A CAISO s implementation of [illegible] Track scoping memo assumptions [illegible] preferred resources H except [illegible] has also not included Track [illegible] supported the a m case [illegible] also run sensitivities exploring [illegible] they use for such sensitivit[illegible] particularly for the hours [illegible] uly day Many of our ORA [illegible]

Q Please comment on CAISO s results

A We have replicated CAISO [illegible] own systems Last minute [illegible] values in their base case [illegible] corrections in our modeling loss [illegible] from solar PV resources that [illegible] modeling

---

31 This is seen in the material made available by CAISO on how the Southern California Import Transmission (SCIT) limited is affected by numerous factors; and is evidenced by the values used by CAISO in its modeling of the transmission limits for the base case, vs. the high DG/DSM case.

32 For example, PacifiCorp and the CAISO have signed a Memorandum of Understanding that could result in PacifiCorp resources being available to be directly dispatched in the CAISO energy markets, and continued efforts to establish a WECC-wide energy imbalance market to improve the scheduling and coordination of power flows across the western regions. Some of this coordination is driver by the FERC's rulings (Order 764) on improved transmission scheduling between balancing areas.

33 Many factors would influence the extent to which California path import capacity could be better utilized with existing assets, or could be increased with increased transmission capacity.

CONCLUSIONS/RECOMMENDATIONS

Q What is your overall concdl ufsoiro mn erwe croems moeu
in the CAISO region by bilityto provide su

A We find that deployingr féfeeasrribeldleresaundrcces
ensure sufficient system fsletxaitbitlditryylei vnels of
resources EE and DR restohuer cheisg hiens tp alretviecl usl at
economically beneficial cAulrsoemen tantyowivarncdrseals
that reflect high incremyemnrteadluc PVigwsouhlodt tlaeg
during the critical period

In our opinion no additionals faorsesirlequfiureeldedatr
because the duration and patatlerandofs umfofdied ieednt
exists to develop incrementalvparlefablreetdorfeisblu
Those resources include innd praerstpiocnuslea rbe y otnadr
considered in the high DRery ciansferse qtuheantt nbeaesdi

Select OTC resources can serdvet oasretiirresur aprocte
schedule if preferred resofuprcoeefperroceudremesnotur
development timelines falls eslhporbtr idgOeTCt hree sgoaup
preferred resource goals are reached

We also note that transmissidnitsyosutelmy icnovnesitdm
especially low hanging fruiitrasnusmisasitohneaMde
supply alternatives noted inetSCEn stheTrLaAkBasit
Diego area relia[34] Tahbeislei tryespduamces can help to imp
more resources to be dispatcehgeid nunder tight c

Q Does this conclude your testimony

A Yes

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[34] Preliminary Reliability Plan for LA Basin and San Diego, Draft, August 30, 2013. Prepared by Staff of the California Public Utilities Commission, California Energy Commission, and California Independent System Operator.

WITNESS QUALIFICATIONS – ROBERT M. FAGAN

Q. Please state your name, position and business address.

A. My name is Robert M. Fagan. I am a Principal Associate with Synapse Energy Economics, Inc., 485 Massachusetts Ave., Cambridge, MA 02139. I have been employed in that position since 2005.

Q. Please state your qualifications.

A. My full qualifications are listed in my resume, on the following pages. I am a mechanical engineer and energy economics analyst, and I have examined energy industry issues for more than 25 years. My activities focus on many aspects of the electric power industry, especially economic and technical analysis of electric supply and delivery systems, wholesale and retail electricity provision, energy and capacity market structures, renewable resource alternatives including on-shore and off-shore wind and solar PV, and assessment and implementation of energy efficiency and demand response alternatives.

I hold an MA from Boston University in Energy and Environmental Studies and a BS from Clarkson University in Mechanical Engineering. I have completed additional course work in wind integration, solar engineering, regulatory and legal aspects of electric power systems, building controls, cogeneration, lighting design and mechanical and aerospace engineering.

Q. Have you testified before the CPUC before?

A. Yes, in Track 1 of this proceeding, and in the A.11-05-023 SDG&E need case. I have also testified in numerous state and provincial jurisdictions, and the Federal Energy Regulatory Commission (FERC), on various aspects of the electric power industry including renewable resource integration, transmission system planning, resource need, and the effects of demand-side resources on the electric power system.

Q. On whose behalf are you testifying in this case?

A. I am testifying on behalf of the California Public Utilities Commission's Office of Ratepayer Advocates (ORA).

WITNESS QUALIFICATIONS – PATRICK LUCKOW

Q. Please state your name, position and business address.

A. My name is Patrick Luckow. I am an Associate with Synapse Energy Economics, Inc., 485 Massachusetts Ave., Cambridge, MA 02139. I have been employed in that position since I started work at Synapse in 2012.

Q. Please state your qualifications.

A. I am an Associate at Synapse, with a special focus on calibrating, running, and modifying industry-standard economic models to evaluate long-term energy plans, and the environmental and economic impacts of policy/regulatory initiatives.

Prior to joining Synapse, I worked as a scientist at the Joint Global Change Research Institute in College Park, Maryland. In this position, I evaluated the long-term implications of potential climate policies, both internationally and in the U.S., across a range of energy and electricity models. This work included leading a team studying global wind energy resources and their interaction in the Institute's integrated assessment model, and modeling large-scale biomass use in the global energy system.

I hold a Bachelor of Science degree in Mechanical Engineering from Northwestern University, and a Master of Science degree in Mechanical Engineering from the University of Maryland.

Q. Have you testified before the CPUC before?

A. No.

Q. On whose behalf are you testifying in this case?

A. I am testifying on behalf of the California Public Utilities Commission's Office of Ratepayer Advocates (ORA).